 a separator, an aqueous alkaline electrolyte, a sealing plate having a safety valve, and a battery case, wherein a discharge capacity of said negative electrode is greater than a discharge capacity of said positive electrode but not greater than 1.1 times as large as a discharge capacity of said positive electrode when said battery, when in a completely charged condition and having a nominal capacity at 1 C, is continuously discharged at an electric current rate of 0.2 to 5 C until a potential of said negative electrode becomes -0.6 V and a potential of said positive electrode becomes -0.1 V with respect to a mercury reference electrode.--

REMARKS

Claims 1, 4, 7, 10, 13 and 16-25 are presently pending in the application.

In Paper No. 4, the Examiner has required an election of species between the allegedly patentably distinct species I (claims 1, 4, 7, 10 and 13), II (claims 2, 5, 8, 11 and 14), and III (claims 3, 6, 9, 12 and 15). While not necessarily agreeing with the Examiner's argument, Applicants hereby confirm the provisional election made orally on September 12, 2002 to elect the claims of Species I (claims 1, 4, 7, 10 and 13), without traverse, for prosecution on the merits. The remaining, non-elected claims have been canceled and replaced with new claims 16-25 as discussed below.

Claim 1 has been amended to change the definition of α to $2.6 \leq \alpha \leq 2.92$.

Support for this amendment may be found in the specification at least at page 17, line 21 to page 18, line 24 and in Figure 1. Claims 4, 7, and 10 have been amended to change "claims 1" to "claim 1" and claim 13 has been amended for clarity. Additionally, new claims 16-25 have been added, which incorporate the subject matter from the canceled claims, but which depend from claim 1 directly or indirectly. Specifically, claim 16 incorporates the subject matter from claim 2, and dependent claims 17-20 incorporate the subject matter from claims 5, 8, 11 and 14, respectively. Similarly, new claim 21 incorporates the subject matter from claim 3, and dependent claims 22-25

incorporate the subject matter from claims 6, 9, 12, and 15, respectively. The language of the new claims reflects the amendments to claims 1, 4, 7, 10, and 13. Further, claims 16 and 21 recite that in addition to satisfying the relationships recited in claim 1, one or two additional relationships hold true in the paste type positive electrodes. No new matter has been added by these amendments. Such claims demonstrate that all of the original claims are directed to one inventive concept, rather than three, as asserted by the Examiner.

The Examiner has objected to the abstract of the present application. The Examiner suggests that the abstract has been switched with the abstract from related application No. 09/146,121, and that the abstract of the present application appears drawn to cobalt having a particular oxidation number. Applicants are confused by the Examiner's comments, as the present abstract (a copy of which is attached for the Examiner's convenience) is essentially a summary of claim 1, and does not even mention the oxidation number of cobalt. In contrast, the abstract of unrelated application No. 09/146,121, now U.S. Patent No. 6,218,046, which is directed to a positive electrode material for alkaline storage batteries which comprise nickel hydroxide particles and a layer of cobalt oxide having a valence greater than 3.0, does recite the oxidation number of cobalt. Accordingly, if the Examiner is to maintain his position regarding the abstract, clarification is respectfully requested.

The Examiner has rejected claims 1, 4, 7, 10 and 13 under 35 U.S.C. § 112, second paragraph, as being indefinite in several respects. First, the Examiner argues that the term "paste type" is a relative term which is not defined by the claim, and that the specification does not provide a standard for ascertaining the required degree. The Examiner contends that it is not clear how the electrode is a paste type and/or what kinds of electrodes were considered to be paste type electrodes at the time of the invention. Furthermore, the Examiner argues that the

term “paste type” may be applied to a process of forming the electrode but may result in an electrode which is not a paste after processing.

Applicants respectfully traverse this rejection, as the term “paste type” is indeed described in the specification at least at page 1, line 21 to page 2, line 4 as having a foamed nickel substrate with pores of approximately 500 μm and a large porosity of approximately 95%. This is contrasted with a “sintered-type” positive electrode, which has pores of approximately 10 μm in diameter and a small porosity of about 10%. From these descriptions, it is apparent what one skilled in the art recognizes by “paste type” electrode, and further that the term cannot apply merely to the process of forming the electrode, but rather describes the resulting electrode. Reconsideration and withdrawal of the rejection are respectfully requested.

The Examiner further argues that the equations in claim 1 are not clearly defined, as the first active material comprises X parts by weight and the second active material comprises Y parts by weight, but that it is unclear using what total weight the parts are determined. Further, the Examiner contends that it is unclear in which way parts by weight are incorporated into equations (1) – (4), and that to arrive at the relationship of equation (4), the parts by weight would appear to have to be expressed as fractions as opposed to percentages since the use of percentages would not arrive at the equation. Applicants respectfully traverse this rejection as follows.

The relative values of X and Y, which represent the parts by weight of particulate nickel hydroxide in the first active material and of nickel oxyhydroxide in the second active material, respectively, are determined by equations (2) and (4). The actual weights of X and Y may then be determined from the relative values of X and Y and the total weight of (X + Y), which is arbitrary and depends on the desired battery capacity. Although the positive electrode contains other materials, such as binder, etc., the amounts of such components would

be obvious to those skilled in the art. In the present invention, regulation of the mean valence of nickel in the positive electrode optimizes the amount of the discharge reservoir of the negative electrode. Accordingly, it is not the total weight of X and Y which is significant in the present invention, but rather the mean valence of nickel, determined from the relative values of X and Y and the valences of nickel contained in the first and second active material,. However, while it is the relationship between the named materials which is important, the absolute amounts could also be calculated. Finally, Applicants do not understand the significance of the Examiner's comments that the weights would have to be expressed as fractions as opposed to percentages, since fractions and percentages are easily interchangeable. For these reasons, reconsideration and withdrawal of the rejection are respectfully requested.

The Examiner further contends that the discharge capacity limitation in claim 13 is unclear. The Examiner argues that the limitation of a supposed nominal capacity rate of 1C is unclear and questions if the limitation following "supposed" is or is not pertinent to the discharge relationship of claim 13. Further, the Examiner contends that the comparison of the potential relative to a mercury electrode is unclear since the conditions of the mercury electrode are not clear. Applicants respectfully traverse this rejection as follows.

Claim 13 describes the discharge current relative to the nominal capacity of the battery. By this amendment, claim 13 has been amended for clarity, including deletion of the phrase "is supposed to have" relating to the nominal capacity. The claim now positively recites that the battery, having a nominal capacity of 1, is discharged at an electric current rate of 0.2 to 5 C (per hour), so that it will take $(1C/5C)/\text{hour}$ to $(1C/0.2C)/\text{hour} = 0.2$ to 5 hours to completely discharge the fully charged battery. The expressions recited in claim 13 are conventional in the art. Further, the mercury electrode is now described as a "reference" electrode, which is known in the art to have a potential of 0 V. The latter half of claim 13 thus means that the discharge

capacity used until a potential of the negative electrode becomes -0.6 V is not greater than 1.1 times the discharge capacity used until a potential of the positive electrode becomes -0.1 V. In other words, when this relationship is satisfied, the negative electrode has a discharge reservoir of not greater than 10%.

For all of these reasons, it is respectfully submitted that all of the claims are in compliance with § 112, and reconsideration and withdrawal of the § 112 rejections are respectfully requested.

The Examiner has rejected claims 1 and 4 under 35 U.S.C. § 103(a) as being unpatentable over JP 11-219701 (“JP ‘701”) in view of WO 98/34290 (“WO ‘290”). Claim 7 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over JP ‘701 in view of WO ‘290 and further in view of U.S. Patent No. 6,083,642 of Kato *et al.* (“Kato”). Finally, the Examiner has rejected claims 10 and 13 under 35 U.S.C. § 103(a) as being unpatentable over JP ‘701 in view of WO ‘290 and further in view of U.S. Patent No. 4,837,119 of Ikoma *et al.* (“Ikoma”). Applicants respectfully traverse these rejections and the arguments in support thereof as follows, and respectfully request reconsideration and withdrawal of the rejections.

Rejection Under 35 U.S.C. § 103(a) Based on JP ‘701 and WO ‘290

Regarding claims 1 and 4, the Examiner argues that JP ‘701 discloses a positive electrode for an alkaline storage battery containing a first active material and a second active material; the first active material comprises X parts by weight of nickel hydroxide (X being 90-60 weight percent of the first and second active materials) with aX/100 parts by weight of cobalt oxyhydroxide (aX/100 being 1-10 weight percent of cobalt oxyhydroxide), and the second active material comprises Y parts by weight of particulate nickel oxyhydroxide (Y being 10-40 weight percent of the first and second active materials) and bX/100 parts by weight of cobalt

oxyhydroxide (bX/100 being 1-10 weight percent of cobalt hydroxide). The Examiner contends that the nickel in the second active material has an inherent oxidation number α and that one of the nickel hydroxide and nickel oxyhydroxide contains at least one of cobalt, zinc, cadmium, magnesium, calcium, manganese, and aluminum.

The Examiner acknowledges that JP '701 does not explicitly disclose the oxidation number of the nickel in the second active material to be from 2.5 to less than 3.0. However, the Examiner contends that the present application shows that the oxidation number of the nickel is affected by the quantity of the 12% by weight NaClO solution, and at a 1 L volume of this solution, as in the examples of JP '701, the nickel oxidation number is determined to be 3.02, just above 3.0.

Further, the Examiner contends that JP '701 discloses that it is known to use an alkali solution of 12% by weight NaClO to promote the oxidation to oxy-nickel hydroxide and that the use of NaClO in such oxidation promoting processes is allegedly well documented. The Examiner further argues that nickel oxyhydroxide including Mn as a solid-solution element can be obtained by oxidizing nickel hydroxide including Mn as a solid-solution element with an oxidizing agent, such as sodium hypochlorite, potassium permanganate, or potassium persulfate.

The Examiner cites WO '290 as teaching that a desired γ ratio can be attained by increasing/decreasing the amount of the oxidizing agent to be added: when a larger amount of the oxidizing agent is added, a higher ratio is obtained. The Examiner thus concludes that one of ordinary skill in the art would have recognized that the oxidation number of the nickel in the nickel oxyhydroxide component could be optimized to a desired level by adjusting the amount of oxidizing agent to be added, and argues that differences in ranges or values are not patentable unless there is evidence of criticality of the claimed range or value. Applicants respectfully traverse this rejection as follows.

First, the Examiner's assertion that the nickel oxidation number in the Example of JP '701 can be determined solely based on the description in the present application is not correct, since the oxidizing agent in JP '701 is a mixed solution of 1 L of NaOH and 1 L of NaClO₄, which differs in oxidizability from the solution of only NaClO in the present application. Regardless, the value of α in claim 1 has been amended to not less than 2.6 and not greater than 2.92. Such a value may be varied depending on the amount of aqueous sodium hypochlorite used. This range of oxidation numbers is particularly desirable because although the valence of nickel could be increased further by using more oxidizing agent, the oxidation efficiency of nickel with the oxidizing agent is extremely low. Therefore, a large amount of oxidizing agent would be required, increasing the production cost of the electrode.

On the other hand, a lower α value ($2.0 < \alpha < 2.5$, for example), is also less desirable. Specifically, if the mean valence of nickel contained in the positive electrode of the present invention is regulated to the values in equation (4) (not less than 2.1 and less than 2.2) by using the second active material with a value of nickel of less than 2.6, the percentage of the second active material in the whole active material will be between 20 and 40%. For example, to regulate the mean valence of nickel to 2.2 by mixing nickel oxyhydroxide with a valence of 2.5 and nickel hydroxide with a valence of 2.0, the amount of second active material x is 40% ($2.5x + 2.0(1-x) = 2.2$). Accordingly, a large amount of the second active material, which requires pre-oxidation treatment of nickel hydroxide using the oxidizing agent, is necessary, and large processing equipment is essential for this preparation (see page 11, line 22 to page 12, line 4). Accordingly, the claimed range is desirable for the present invention.

However, both JP '701 and WO '290 are completely silent as to the effect of α on the cost of the resulting positive electrode, which may be lowered using α in the claimed range.

Neither reference teaches or suggests that the claimed range of oxidation numbers is preferable or desirable.

Further, although the example of WO '290 discloses the relation between the amount of the oxidizing agent and the γ ratio of nickel oxyhydroxide (the ratio of γ -type nickel oxyhydroxide and α -type nickel oxyhydroxide), it does not teach or suggest the relation between the amount of the oxidizing agent and the valence of nickel oxyhydroxide.

Finally, neither JP '701 nor WO '290 teaches or suggests the preferred range of the mean valence of nickel represented by equation (4) of the present claims. For example, since JP '701 does not disclose the valence of nickel in the second active material, it would not be obvious based on this reference to regulate the mean valence of nickel contained in the whole active material, as described at page 5, line 16 to page 6, line 11 of the specification, or to regulate the amount of the discharge reservoir of the negative electrode to a proper level. Therefore, based on the proposed combination, it would not be obvious to one skilled in the art how to obtain a low-cost battery with a high capacity and a long cycle life which has the claimed characteristics.

Specifically, according to the present invention, the amount of the discharge reservoir of the negative electrode can be optimized by regulating the mean valence of nickel in the positive electrode. As a result, it is possible to reduce the amount of expensive hydrogen storage alloy to be used, thus enabling the production of a low-cost battery with a high energy density (page 31, lines 6 to 11). For example, a battery with a discharge reservoir of not greater than 10% (such as recited in claim 13 and described at page 27, line 17 to page 28, line 16 and in Tables 1 and 2) can be produced. As shown in Tables 1 and 2, the batteries according to the present invention (1, 2, and 3) exhibited favorable properties relative to the comparative examples, which is due in part to the difference in oxidation number of nickel in the positive

electrodes. It is noted that Comparative Example 13 is the example from JP '701, which is clearly inferior to the presently claimed electrodes. This demonstrates the superiority of the present invention over the prior art.

For all of these reasons, the Examiner has not established a *prima facie* case of obviousness based on the proposed combination of JP '701 and WO '290, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under 35 U.S.C. § 103(a) Based on JP '701, WO '290, and Kato

Regarding claim 7, the Examiner acknowledges that JP '701 and WO '290 do not teach that the oxidation number of the cobalt in the oxyhydroxide in the active materials is greater than 3. However, the Examiner contends that Kato discloses a process in which the nickel active material is coated with cobalt having an oxidation number greater than 3, and that using a higher valence cobalt material provides a positive electrode material having high active material utilization and improved overdischarge withstanding characteristics. Therefore, the Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the teaching of JP '701 by providing a higher valence cobalt material to provide such favorable properties. Applicants respectfully traverse this rejection as follows.

There are several reasons for utilizing cobalt oxyhydroxide having a cobalt valence greater than 3 in the claimed active materials. First, since the valence of cobalt can change to 3 during charge/discharge cycles, if the valence of cobalt is initially less than 3, a discharge reservoir, which is undesirable for the negative electrode, is produced while the valence of cobalt changes to 3 in the battery. On the other hand, when cobalt oxyhydroxide with a valence of cobalt of greater than 3 is used initially, the valence of cobalt does not change and such excessive discharge reservoir can be eliminated. In addition, since cobalt oxyhydroxide

with a valence of cobalt of greater than 3 is very stable throughout the long cycle of charge/discharge, it is possible to accurately set the discharge reservoir.

Further, the second active material can be obtained efficiently by further subjecting the first active material to an oxidation treatment. However, if the valence of cobalt in the surface layer of the first active material is 3, the utilization rate of the second active material obtained from oxidation of the first active material will be low compared with the utilization rate of the first active material before oxidation. On the contrary, if the valence of cobalt in the surface layer is greater than 3, specifically, 3.12 or 3.19, the second active material utilization rate is almost the same as that before oxidation, because the cobalt compound having a cobalt valence greater than 3 has a more stable structure in which alkali cations are intercalated between the layers.

In summary, the use of cobalt oxyhydroxide with a valence of cobalt of greater than 3 used in claim 7 eliminates the excessive discharge reservoir due to the valence change of cobalt, avoids the variations in the discharge reservoir, and prevents the second active material utilization rate from decreasing.

Kato teaches coating nickel active material with cobalt having an oxidation number greater than 3 for providing a high active material utilization rate and improved overdischarge withstanding characteristics. However, Kato does not teach or suggest that regulating the valence of cobalt in cobalt oxyhydroxide would additionally stabilize the cobalt oxyhydroxide, which significantly affects and optimizes the discharge reservoir. Accordingly, it would not be expected based on the proposed combination that to apply cobalt oxyhydroxide with a valence of cobalt of greater than 3 to JP '701, combined with regulating the mean valence of nickel contained in the positive electrode as claimed, would eliminate the excessive discharge reservoir due to the valence change of cobalt and avoid the variations in the discharge reservoir.

For these reasons, no *prima facie* case of obviousness has been established by the Examiner, and reconsideration and withdrawal of the § 103(a) rejection based on JP '701, WO '290 and Kato are respectfully requested.

Rejection Under 35 U.S.C. § 103(a) Based on JP '701, WO '290, and Ikoma

Regarding claims 10 and 13, the Examiner acknowledges that JP '701 and WO '290 do not teach that the battery further comprises a negative electrode comprising a hydrogen storage alloy, a separator, an aqueous alkaline electrolyte solution, a sealing plate having a safety valve and a battery case as claimed. However, the Examiner contends that such modifications of the overall components of the battery would have been readily apparent. Further, the Examiner argues that Ikoma discloses a sealed storage battery comprising a positive electrode, negative electrode, separator, aqueous electrolyte solution, and a sealing plate having a safety valve. In order to measure the performance of the cells of JP '701 having positive electrodes, the presence of an opposing negative electrode is allegedly required, as well as an electrolyte solution to enable charge transfer in the battery, and Ikoma allegedly teaches the use of a positive electrode, negative electrode, and aqueous alkaline electrolyte solution. Therefore, the Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the teachings of JP '701 by providing a negative electrode and electrolyte solution to effectively enable charge transfer from the positive electrode to a second electrode across the electrolytic medium.

The Examiner further argues that it would have been obvious to modify JP '701 by using a separator, allegedly an obvious addition in manufacturing a cell, to electrically isolate the positive and negative electrode materials. Regarding the sealing plate, which is allegedly taught by Ikoma to seal the battery components from the external atmosphere, the Examiner

argues that it would have been obvious to modify JP '701 by providing a sealing plate to the open end of a battery since it would have sealed the battery components within the battery and isolated them from the external environment. Finally, the Examiner argues that Ikoma describes providing a safety valve in the sealing plate which releases the gas generated in the battery when the inner pressure rises above a given value in order to prevent damage to the battery and explosion in case of abnormal increase of internal pressure. Therefore, the Examiner concludes that it would have been obvious to modify JP '701 by providing a safety valve in the sealing plate to compensate for internal pressure fluxes. Applicants respectfully traverse this rejection as follows.

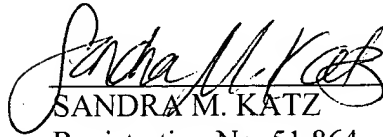
Ikoma teaches a sealed storage battery comprising a positive electrode, a negative electrode, an alkaline electrolyte, a separator, and a sealing plate having a safety valve. However, the storage battery recited in the present claims 10 and 13 has a paste type positive electrode according to claim 1. As previously explained, neither JP '701, WO '290 nor their combination teaches or suggests all of the elements of claim 1, and Ikoma does not cure these deficiencies. Further, regarding claim 13, none of the cited references teaches or suggests the claimed discharge properties. For these reasons, no *prima facie* case of obviousness has been established based on the proposed combination of JP '701, WO '290 and Ikoma, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Based on the preceding Amendments and Remarks, it is respectfully submitted that the pending claims are in compliance with § 112. In view of the Remarks, Applicants submit that the pending claims are patentable, distinct from the prior art of record, and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,
FUTOSHI TANIGAWA et al.

March 31, 2003
(Date)

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Enclosures: Petition for Extension of Time (two months), Copy of abstract of present application

Marked-Up Version of Claims

--1. (Amended) A paste type positive electrode for an alkaline storage battery containing a first active material and a second active material, wherein said first active material comprises X parts by weight of particulate nickel hydroxide with $aX/100$ parts by weight of cobalt oxyhydroxide carried thereon, and said second active material comprises Y parts by weight of particulate nickel oxyhydroxide, of which an oxidation number of nickel is α , with $bY/100$ parts by weight of cobalt oxyhydroxide carried thereon, all the following relationships being satisfied:

(1) $[2.5] \underline{2.6} \leq \alpha \leq \underline{2.92} [< 3.0]$

(2) $0.01 \leq (aX/100 + bY/100) / (X + Y) \leq 0.20$

(3) $0 < b \leq a \leq 10$ or $0 = b < a \leq 10$

(4) $2.1 \leq (2X + \alpha Y) / (X + Y) < 2.2.$

4. (Amended) The paste type positive electrode in accordance with claim[s] 1, wherein at least one of said particulate nickel hydroxide and said particular nickel oxyhydroxide is a solid solution containing at least one selected from the group consisting of cobalt, zinc, cadmium, magnesium, calcium, manganese, and aluminum.

7. (Amended) The paste type positive electrode in accordance with claim[s] 1, wherein an oxidation number of cobalt in said cobalt oxyhydroxide included in said first active material and said second active material is greater than 3.

10. (Amended) A nickel-metal hydride storage battery comprising a paste type positive electrode in accordance with claim[s] 1, a negative electrode comprising a hydrogen storage alloy, a separator, an aqueous alkaline electrolyte, a sealing plate having a safety valve, and a battery case.

13. (Amended) A nickel-metal hydride storage battery comprising a paste type positive electrode in accordance with claim[s] 1, a negative electrode comprising a hydrogen storage alloy, a separator, an aqueous alkaline electrolyte, a sealing plate having a safety valve, and a battery case, wherein a discharge capacity of said negative electrode is greater than a discharge capacity of said positive electrode but not greater than 1.1 times as large as a discharge capacity of said positive electrode when said battery, when [which is] in a completely charged condition and [is supposed to have] having a nominal capacity at 1 C [rate], is continuously discharged at an electric current rate of 0.2 to 5 C [rate] until a potential of said negative electrode becomes -0.6 V and a potential of said positive electrode becomes -0.1 V with respect to a mercury reference electrode.--



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ABSTRACT OF THE DISCLOSURE

The paste type positive electrode of the present invention contains a first active material and a second active material. The first active material comprises X parts by weight of particulate nickel hydroxide with $aX/100$ parts by weight of cobalt oxyhydroxide carried thereon. The second active material comprises Y parts by weight of particulate nickel oxyhydroxide, of which an oxidation number of nickel is α , with $bY/100$ parts by weight of cobalt oxyhydroxide carried thereon. Here, all the following relations are satisfied:

(1) $2.5 \leq \alpha < 3.0$, (2) $0.01 \leq (aX/100 + bY/100) / (X+Y) \leq 0.20$,
(3) $0 < b \leq a \leq 10$ or $0 = b < a \leq 10$, and
(4) $2.1 \leq (2X + \alpha Y) / (X+Y) < 2.2$.